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ABSTRACT

A study investigated children's difficulty in learning color words and attempted to determine whether the difficulty was perceptual, conceptual, or linguistic. The subjects were 24 two-year-olds, half with knowledge of color words and half without, and a similar control group. The experimental subjects were given conceptual and comprehension tasks for which the responses depended on color discrimination. In all cases, color was available as an inferential tool to the children who knew no color words, reducing the likelihood but not ruling out the possibility of a conceptual obstacle. However, children who knew color words appeared to do no better on the nonlinguistic color tasks than those without knowledge of color words. Possible explanations concern different kinds of linguistic or conceptual constraints at work. (MSE)

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Color Word Acquisition: Conceptual or Linguistic Challenge

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Color Word Acquisition: Conceptual or Linguistic Challenge

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Many researchers have noted children's incredible facility in learning new words and have used this facility to draw conclusions about the process of word learning (Brown, 1970; Carey & Bartlett, 1978; Katz, Baker, & Macnamara, 1974; Markman & Hutchinson, 1984, Nelson & Bonvillian, 1973; Ovaitt, 1982). This paper examines the converse -the difficulty children experience in learning certain words, color words.

Mabel Rice (1980) has demonstrated that many children who do not know any color words do not easily learn a word that refers to a color. She used operant conditioning to teach children to say "red" and "green" correctly to red and green objects. The children needed an average of 796 trials to learn to respond appropriately.

This difficulty is striking when compared to the skill that children who know color words have in learning a new color word. Heibeck and Markman (1986) have shown that children who know color words make an initial mapping of a new color word after hearing it only twice. Furthermore, Carey and Bartlett (1978) have shown that this "fast mapping" happens equally well with children who know only one other color word and children that know nine or more other color words.

The two results just described —the difficulty in teaching a first color word and the ease in teaching subsequent color words— suggest that children face an obstacle when learning words in a new conceptual domain, at least in the color domain. The focus of this paper is identifying the obstacle in the color domain. The question is: is the problem perceptual, conceptual, or linguistic?

The source of the obstacle could not be perceptual discrimination. Bornstein, Kessen, and Weiskopf (1976) have demonstrated that at four months infants can discriminate colors and appreciate at least some of the color boundaries that adults perceive. Infants have perceptual color categories. Therefore, young children must face either a conceptual obstacle or a linguistic obstacle to learning their first color word.

What could a conceptual obstacle be like, given that infants have perceptual color categories? The answer is based on the difference between perception and conception. The significant thing about concepts is that they are the basis for inductive inferences. In order to use color in inductive inferences, color must be perceptually available; however, that perceptual availability does not guarantee conceptual status. It could be that the conceptual system of a child who does not know color words is constrained such that color is never considered as a basis for inferences even though it is discriminated. This kind of constraint would prevent children from hypothesizing color to be the referent of a word and will be called the conceptual obstacle.

An alternative hypothesis is that the obstacle is purely linguistic. Children may be capable of using color in inductions, but

not in inductions of word meaning. In other words it could be that color is not a nameable concept at an early point in word learning. This kind of constraint will be called the linguistic obstacle.

Mabel Rice (1980) and Linda Smith (1984) have independently attempted to determine which obstacle (conceptual or linguistic) is functioning and both argued for a conceptual obstacle. They found that the children who had difficulty on color word tasks also had difficulty on nonlinguistic tasks requiring inductions based on color. To decide between the two hypotheses it is imperative that children who know no color words be compared with children who know one or more color words. However, neither Rice's procedure nor Smith's procedure divides children this way. That is, Rice's subjects were bilingual, but their knowledge of color words was only assessed in English. They may have known color words in another language. Smith's experiment was not designed to discriminate children who knew no color words from children who knew only a few color words. Therefore, the Rice (1980) and Smith (1984) experiments leave open the question of whether children who do not know color words use color in any inductions.

The following experiments address that question. Children were tested for their linguistic and conceptual knowledge of colors. The linguistic task revealed exactly the number of color words known. The conceptual tasks necessitated the use of color. There were also control tasks that were structurally similar to the color tasks but did not depend on color. These tasks were used to compare the relative effects of the children's representation of color with their understanding of other aspects of the task.

In sum, in order to support the conceptual obstacle hypothesis, it must be shown that there is a task that depends on inductions based on color that cannot be done by children who know no color words, and yet can be done by children who know even just one color word. Also, it must be shown that the difference between the children is not due to task-related demands that are independent of color. In contrast, to support the linguistic obstacle hypothesis all the children must be able to do the conceptual tasks. This result would demonstrate that children who know no color words can use color in inductive inferences. In this case a second question arises: do children who know color words do better on nonlinguistic color tasks than children who do not know color words? It could be that children who do not know color words have a representation of color and yet the learning of color words makes color even more available for inductive inference.

EXPERIMENT 1

Method

Subjects

In the main task there were 12 subjects who knew color words and 12 subjects who did not. The mean age was 2 years, 1 month (range: 1:11 - 2:4) and 2 years exactly (range: 1:10 - 2:2), respectively. 24 different subjects (12 who knew color words and 12 who did not) were given a control task. The mean ages were also 2:1 and 2:0. Half the subjects in each group were male and half were female.

Procedure and Stimuli

The subjects were first tested for their knowledge of color words. Then half of the subjects were given a task that necessitated the use of color. The remaining subjects were given the control task. The control was very similar to the color task except that color was not a relevant factor.

Knowledge of Color Words

Knowledge of color words was assessed in a comprehension task. The eleven colors selected by Berlin and Kay (1969) as the basic colors (red, blue, green, yellow, purple, pink, orange, brown, white, black, grey) were represented with pieces of construction paper and crayons. They matched the focal color for each color as determined by Heider (1971).

Five or six colors of one medium (paper or crayon) were placed in front of the subject (S). The experimenter (E) asked questions of the form, "Can you find the red paper/crayon?" about each color. Then the remaining five or six colors were presented and the procedure was repeated. At this point each color had appeared exactly one time. Then, the whole process was repeated. In the second run, the colors were grouped and arranged differently than in the first run and the other medium was used. This procedure resulted in each color being presented and selected by the experimenter twice. If the subject chose the red one, for example, both times that the experimenter asked for it and not more than one other time (in a run) when a different color was correct, then the subject was credited with knowing the word "red". If a subject knew even one color word, then he was placed in the "know color words" group. To be placed in the "do not know color words" group a subject had to fail on all color words.

Nonlinguistic task -dependence on color

There were eight pairs of small objects. In each pair the two objects differed only in color (Figure 1).

Figure 1

For example, one pair was two strollers, one purple and one orange. The other pairs are listed in Appendix 1. The E showed the S both objects of a pair and let the S choose one. The E then said "This is your stroller. This stroller is yours. And this is my stroller. This stroller is mine" pointing appropriately. They then played with their own toys for a short while. The E continued to use the phrases "your stroller" and "my stroller" as dictated by the play. The E then put the strollers side by side and asked the S "put your stroller in this bag". The S's visual contact with the objects was briefly interrupted before the objects were presented for the test question. The sides of the S's and E's toys were counterbalanced. The eight trials were preceded by a practice pair consisting of a red bureau and a yellow cup.

Control Task -no dependence on color

There were 8 pairs of objects. The two objects within a pair were

identical (e.g. two purple strollers were used). Seven of the object types were the same as the first seven objects in the color task in the first color listed for each. The eighth object type was a green dog. The procedure was the same as in the color task until the E took both objects. In the control task each person put his object down in front of himself. Then the E asked either "put your stroller in this bag" or "put my stroller in this bag." Each question was asked in four trials in a random order. The reason for the difference in procedures is as follows. The toys had to remain near the owners spatially to be kept distinct. Since the position of the objects was biasing, it was necessary to ask the S to choose the E's toy in half of the trials. The purpose of the control was to determine knowledge of possession words and it achieved this goal.

Results

All subjects did better than chance on both tasks (Figure 2).

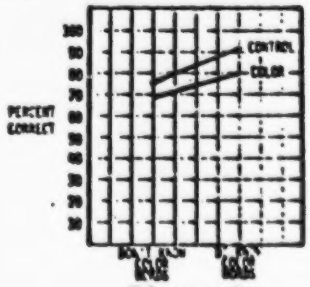

Figure 2

The performance of the subjects who knew color words was 80% on the color task (t (22) = 4.719, $p < .0002$, 2-tailed) and 93% on the control task (t (22) = 7.754, $p < .000002$, 2-tailed). The performance of the subjects who did not know color words was 69% on the color task (t (22) = 2.989, $p < .01$, 2-tailed) and 75% on the control task (t (22) = 4.449, $p < .0005$, 2-tailed).

A two-way ANOVA comparing knowledge (know color words x do not know color words) X task (color x control) revealed a knowledge main effect only (F (1, 44) = 6.041, $p = .018$, 2-tailed). There was no main effect of task (F (1, 44) = 2.494, $p = .121$, 2-tailed) and no interaction between task and knowledge of color words (F (1, 44) = .345, $p = .56$, 2-tailed).

In sum, all the subjects could do both tasks. The subjects who knew color words did better than the subjects who did not know color words, but this benefit did not depend on the task.

Discussion

The first question asked was: do children who do not know color words use color in any inductive inferences? To do the color task correctly, the subjects had to select color for coding in their representation of the object. And they had to use it as the basis of their inferences about ownership. Subjects who know no color words succeeded. Therefore, color is conceptually available for them, at

least as a specification of an individual object.

The second question was: do children who know color words do better than children who do not know color words on nonlinguistic color tasks? The advantage had by subjects who knew color words was not specific to the color task. Therefore, their advantage must be due to their knowledge of possessive words rather than their ability to represent color. Possibly children who know color words are more verbally advanced than children who do not know color words in a variety of linguistic domains.

However, there was a problem with the comprehension task. Some of the subjects appeared to have no understanding of the task and refused to complete it. These subjects were scored as not knowing color words. But, it could be that they did know one or more color words and raised the mean of the "do not know color words" group. To solve this problem a new comprehension task was designed that all the subjects enjoyed and understood.

Experiment 2 used a new conceptual task, as well as the new comprehension task. In the new conceptual task, the E chose one object and the S was expected to choose an object that was the same as the E's out of two alternatives. As in Experiment 1, the subjects needed to compare a mental representation of the target object with their representation of two objects being visually presented (Figure 3)..

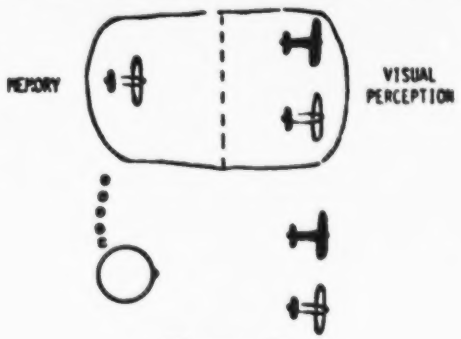

Figure 3

EXPERIMENT 2

Method

Subjects

There were 24 subjects. 12 subjects knew color words and 12 did not. 6 of the subjects in each group were male and 6 were female. The mean age was 2:0 (range: 1:11 - 2:3) for the subjects who did not know color words and 2:1 (range: 1:10 - 2:3) for the subjects who did know color words. Three additional subjects were dropped because they did not reach the criterion of the training task. One subject knew color words and two did not.

Procedure and Stimuli

The subjects were first tested for their comprehension of color words. They were then given two training tasks and the nonlinguistic task requiring color.

Knowledge of Color Words

In this comprehension task felt bags replaced the papers and crayons. Each bag had a toy inside. Again, five or six bags of different colors were presented to the S. The E said, "These are bags and there is a toy in each bag". The E showed that one of the other bags opened and had a toy inside. The E then said "Can you find the toy in the red bag". Again, each color was presented twice. The same criterion for assessing whether the child knew one or more color words was used as in Experiment 1.

Truck Training

The E and the S played with a truck and some blocks. After a short free-play period the E put one block on one part of the truck and asked the S to do the same. The E corrected the S if the S put the block in a different place. They played this game until the S learned to follow the E's actions without feedback. At that point the E said "Let's play this game with some other toys," and the second training began.

Second Training Task

This procedure is a modified version of the follow-the-leader procedure used by Smith (1984). The E presented four objects (Figure 4). The objects are listed in Appendix 1.

Figure 4

She put two in front of the S and two in front of herself. The E's two objects were different from each other with respect to kind, shape, size, and color. The S's pair was identical to the E's pair. The E then selected one object and put it in an open box and said, "You put one of your toys in here". The correct toy was the one that was identical to the toy the E had chosen. Although the verbal command did not specify the correct toy, the truck training set up a context in which the S knew to do the same thing that the E had done. In this training task there was no feedback concerning the correct choice. After the subject chose one toy, the E began the next trial without correction. However, if the S chose both toys, the E put all the toys back in their original positions and said, "See, I'm leaving this toy here and putting this toy, just this toy, in the box. You take one toy, just one of them, and put it in the box. Leave one toy there".

There were eight trials. If the S chose the correct toy in six or more of the trials, the E continued the game with the toys from the task that required inductions based on color. Otherwise the subject was dropped. Three subjects were dropped: one knew color words and two did not. The sides of placement were counterbalanced such that the correct response was equally distributed on the subject's left and right sides.

Task Requiring Inductions Based On Color

The procedure in this task is identical to the procedure of the second training task. In fact, the subjects experienced the two tasks as one continuous game. The difference between the tasks was in the

relationship between the objects (Figure 5).

Figure 5

The E's two objects differed in color, but were otherwise identical. The objects are listed in Appendix 1. The S's object pair was identical to the E's, as in the second training task. The correct toy was the one of the same color as the toy chosen by the E. Again feedback was only given when the S chose both objects.

The second training task is training for this task (the color task) because it is structurally similar, yet is easier because the selection of the correct toy can be made on the basis of many different factors. The training task is also a control in that the S needed to use color to choose correctly in the color task but not in the training task.

Results

The subjects were significantly better than chance on both kinds of trials (Figure 6).

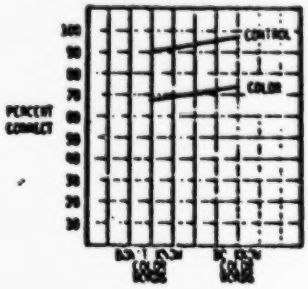

Figure 6

The subjects who knew color words did 98% of the control trials correctly (t (11) = 35.605, $p < .0000002$, 2-tailed) and 74% of the color trials correctly (t (11) = 3.936, $p < .005$, 2-tailed). The subjects who did not know color words did 90% of the control trials correctly (t (11) = 13.323, $p < .0000002$, 2-tailed) and 68% of the color trials correctly (t (11) = 2.068, $p = .034$, 1-tailed).

A two-way anova comparing knowledge (know color words x do not know color words) X trial type (control x color) revealed a trial type main effect only (F (1, 22) = 16.713, $p < .0005$, 2-tailed). There was no main effect of color word knowledge (F (1, 22) = 1.459, $p = .24$, 2-tailed). There was no interaction between trial type and color word knowledge (F (1, 22) = .08, $p = .78$, 2-tailed).

On the comprehension test, the chance of a subject who knew no color words in getting one color word right was .18. There were two subjects in the "know color words" group who only got one color word correct. It is possible that they, in fact, did not know any color

words; and that they masked differences between the two groups by lowering the means on the control and color tasks. However, this possibility is not a real problem because the two subjects performed at the higher end of the range of scores for their group.

In sum, the subjects were better than chance on both kinds of trials. The color trials were harder than the control trials, but this result is somewhat artificial because the subjects who did worse than 75% on the control trials were dropped. There was no difference in performance between the subjects who knew color words and the subjects who did not know color words.

General Discussion

The major result of Experiment 1 (that color is available to children who do not know color words) was replicated in Experiment 2. Subjects who knew no color words selected color for representation and used it as the basis of their inferences about ownership and similarity. These data rule out the conceptual obstacle hypothesis and support the linguistic obstacle hypothesis. Children need to learn that names can refer to colors.

What sort of reasonable linguistic constraint would inhibit the learning of certain kinds of words? Below are two examples of the kind of constraint that could be functioning.

The first is that children only lexicalize properties that have functional relevance. Various properties, like object-type, size, and ownership, determine what you can do with an object. Color, on the other hand, has very little functional relevance for most objects. Although children do use color to specify objects, as has just been shown, the color itself rarely determines what can be done with the object. Color is not embedded in a rich explanatory structure. One possible constraint, in sum, is that only functionally relevant properties are lexicalized.

The second possible linguistic constraint is proposed by Landau and her colleagues (Landau & Gleitman, 1985; Park, Tsukagoshi & Landau, 1985). They suggest that children believe that property words refer to relative properties as opposed to absolute properties. In the color domain, light and dark are relative properties. For an object to be light it must be relative to a standard that is darker or another object that is darker. In contrast, a color can be red without being compared to any other colors. This constraint, then, is that only relative properties are lexicalized.

However, an alternative argument is that the conceptual obstacle has not been rejected. To do the tasks children needed, minimally, to have an integral representation of color. That is, they could have made a wholistic comparison of the objects rather than a feature-by-feature comparison. However, to learn color words, children need to represent color independently from any particular object. These experiments were a first pass at investigating the conception of color had by children who do not know color words. More research needs to be done to see whether, in fact, they have a separable representation of color.

Given that children who do not know color words can base some inductions on color, the second question raised in the introduction

must be addressed. That is, do children who know color words do better at nonlinguistic color tasks than children who do not know color words? The answer in these experiments is no. The advantage due to knowledge in Experiment 1 was the same regardless of the relevance of color and there was no advantage in Experiment 2. However, there may be other nonlinguistic color tasks that do favor children who know color words.

In conclusion, it should be emphasized that the linguistic constraints described above are not maladaptive. Objects, hypothetically, can be characterized by an infinite number of features and relations. If the range of possible word meanings were not constrained, children would never learn a single word. By constraining the kinds of referents a word can have, children are able to learn thousands of words in a few years. However, these constraints may inhibit the acquisition of certain kinds of words, like color words. The examination of these negative effects as well as the positive effects will enlighten our understanding of knowledge acquisition and representation.

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APPENDIX 1

Materials

Experiment 1	Experiment 2	
	Control/Training	Color Trials
strollers (purple orange)	Indian figures and dinasours	high chairs (orange pink)
bears (pink blue)	tops and plastic grids	chickens (yellow green)
planes (red green)	dogs and bottles	balls (orange purple)
hangers (yellow pink)	curlers and rubber jar openers	trucks (blue yellow)
shovels (red blue)	shoes and hair brushes	horses (red green)
cribs (orange green)	chess pieces and handles to peelers	spoons (blue purple)
keys (blue yellow)	chairs and cups	combs (pink green)
hair brushes (green purple)	plastic semicircles and radish flowerers	men (red blue)